FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
218108US2PCT

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR
10/069516

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/04408	**3 July 2000**	**None**

TITLE OF INVENTION
METHOD OF AND DEVICE FOR CORRECTING A TIMING

APPLICANT(S) FOR DO/EO/US
AIKAWA Hideto et al.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   - a. ☐ is attached hereto (required only if not communicated by the International Bureau)
   - b. ☒ has been communicated by the International Bureau.
   - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   - a ☒ is attached hereto.
   - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ have been communicated by the International Bureau.
   - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☐ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

Form PTO-1449/Drawings (4 pages)/Substitute Figures (1)
Letter Requesting Entry of Substitute Drawings
List of Related Cases/Cited Pending Application (1)

JC19 Rec'd PCT/PTO 04 MAR 2002

U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR) 10/069516	INTERNATIONAL APPLICATION NO. PCT/JP00/04408	ATTORNEY'S DOCKET NUMBER 218108US2PCT

24. The following fees are submitted:.	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**		
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	CALCULATIONS	PTO USE ONLY
Total claims	18 - 20 =	0	x $18.00	**$0.00**	
Independent claims	2 - 3 =	0	x $84.00	**$0.00**	
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$890.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**	
SUBTOTAL =				**$890.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$890.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**	
TOTAL FEES ENCLOSED =				**$890.00**	
				Amount to be: refunded	$
				charged	$

a. ☒ A check in the amount of **$890.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ______ in the amount of ______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☐ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **15-0030** A duplicate copy of this sheet is enclosed.

d. ☒ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Surinder Sachar
Registration No. 34,423

22850

Surinder Sachar

SIGNATURE

Marvin J. Spivak

NAME

24,913

REGISTRATION NUMBER

March 4 2002

DATE

10/069516

JC19 Rec'd PCT/PTO 04 MAR 2002

Docket No. 218108US2PCT

IN RE APPLICATION OF: Hideto AIKAWA et al.

SERIAL NO: New U. S. PCT Application (Based on PCT/JP00/04408)

FILED: HEREWITH

FOR: METHOD OF AND DEVICE FOR CORRECTING A TIMING

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Transmitted herewith is an amendment in the above-identified application.

☒ No additional fee is required

☐ Small entity status of this application under 37 C.F.R. §1.9 and §1.27 is claimed.

☒ Additional documents filed herewith: PCT Transmittal Letter, English Translation of Specification/Declaration/Form PTO-1449/Information Disclosure Statement/International Search Report Drawings (4 sheets)/Letter Requesting Entry of Substitute Drawings/Substitute Figures (1)/List of Related Cases/Cited Pending Applications (1)/Check for $890.00

The Fee has been calculated as shown below:

CLAIMS	CLAIMS REMAINING		HIGHEST NUMBER PREVIOUSLY PAID	NO. EXTRA CLAIMS	RATE	CALCULATIONS
TOTAL	18	MINUS	20	0	× $18 =	$0.00
INDEPENDENT	2	MINUS	3	0	× $84 =	$0.00
		☐ MULTIPLE DEPENDENT CLAIMS			+ $280 =	$0.00
		TOTAL OF ABOVE CALCULATIONS				$0.00
		☐ Reduction by 50% for filing by Small Entity				$0.00
		☐ Recordation of Assignment			+ $40 =	$0.00
		TOTAL				$0.00

☐ A check in the amount of **$0.00** is attached.

☒ Please charge any additional Fees for the papers being filed herewith and for which no check is enclosed herewith, or credit any overpayment to deposit Account No. 15-0030. A duplicate copy of this sheet is enclosed.

☒ If these papers are not considered timely filed by the Patent and Trademark Office, then a petition is hereby made under 37 C.F.R. §1.136, and any additional fees required under 37 C.F.R. §1.136 for any necessary extension of time may be charged to Deposit Account No. 15-0030. A duplicate copy of this sheet is enclosed.

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

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218108US-2 PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: :

HIDETO AIKAWA ET AL : ATTN: APPLICATION DIVISION

SERIAL NO: NEW U.S. PCT APPLN :
(BASED ON PCT/JP00/04408)

FILED: HEREWITH :

FOR: METHOD OF AND DEVICE FOR CORRECTING A TIMING

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE DRAWINGS

Approval of the substitute drawing for Figure 1 is hereby respectfully requested.

REMARKS

The present preliminary amendment is submitted to set forth a substitute Figure 1. Substitute Figure 1 corrects for the labeling of element blocks 1 and 7 in original Figure 1. More specifically, in substitute Figure 1 block element 1 is now more properly labeled as a

"Rake Path Detecting Circuit" and block element 7 is now more properly labeled as a "Clock Generating Circuit".

The submission of substitute Figure 1 is not believed to raise any issues of new matter and substitute Figure 1 is believed to be more consistent with the original disclosure.

The present application is believed to be in condition for a full and thorough examination on the merits. An early and favorable consideration of the present application is hereby respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.

Surinder Sachar

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10/069516

JC19 Rec'd PCT/PTO 04 MAR 2002

DOCKET NO. 218108US-2 PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: : ATTN: APPLICATION DIVISION

HIDETO AIKAWA ET AL :

SERIAL NO. NEW U.S. PCT APPLN (BASED ON PCT/JP00/04408) :

FILED: HEREWITH :

FOR: METHOD OF AND DEVICE FOR CORRECTING A TIMING :

LETTER REQUESTING ENTRY OF SUBSTITUTE DRAWINGS

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Please review the attached substitute Figure 1 for entry as a replacement for the original Figure 1 in the above-identified application.

Respectfully submitted,

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10/069516
JC19 Rec'd PCT/PTO 04 MAR 2002

SPECIFICATION

TITLE OF THE INVENTION

Method of and device for correcting a timing

TECHNICAL FIELD

This invention relates to a timing correcting device within a mobile station accommodated in a mobile communication system that employs a CDMA (Code Division Multiple Access) system. Particularly, the invention relates to a timing correcting device within a mobile station and a timing correcting method for executing a timing control necessary for establishing a synchronization of CDMA communication signals.

BACKGROUND ART

Conventional techniques will be explained below. For example, in a mobile station accommodated in a mobile communication system that employs a CDMA system, a reception timing of a receiving channel corresponding to a reception signal is detected by executing an inverse diffusion processing and a demodulation processing to pilot signals received in a predetermined period. Usually, in a mobile communication environment, reception signals are detected as a plurality of reception timing candidates in a RAKE path

detector. In this case, paths detected as candidates have mutually different correlation values and reception timings.

At a mobile station, a main reception timing is determined from among the plurality of reception timing candidates. Specifically, at the mobile station, a reception reference timing held in advance is compared sequentially with the latest reception timing candidates. Then, the reception reference timing, that is, a clock to be managed inside, is corrected so that the reception reference timing coincides with an optimum reception timing that has been determined based on a result of the comparison.

In this way, at the mobile station, the optimum reception reference timing is obtained by absorbing a clock deviation between the mobile station and a base station, and a clock deviation due to a variation in a transmission distance, based on a clock correction.

As a concrete example of a timing correcting device for obtaining the optimum reception reference timing, there is a device disclosed in Japanese Patent Application Laid-open (JP-A) No. 11-261410, for example. Fig. 4 is a diagram showing a structure of a conventional timing correcting device described in the above publication. In Fig. 4, 101 denotes a reception timing detecting circuit, 102 denotes a comparator circuit, 103 denotes a reference

timing generating circuit, 104 denotes a clock generating circuit, 105 denotes a timing correction control circuit, and 106 denotes a correction speed control circuit.

The operation of the timing correcting device will be explained. To begin with, the reception timing detecting circuit 101 generates a reception timing signal S(2) based on a pilot signal S(1) included in a reception signal, and outputs this to the comparator circuit 102.

On the other hand, the reference timing generating circuit 103 generates a reference timing signal S(4) of a period that is substantially the same as the period of the reception timing signal S(2), based on a clock signal S(3) received from the clock generating circuit 104, and outputs this to the comparator circuit 102.

The comparator circuit 102 compares the reception timing signal S(2) with the reference timing signal S(4), and outputs a result of this comparison to the timing correction control circuit 105 as a comparison result signal S(5).

When the comparator circuit 102 has detected a deviation between the reception timing signal S(2) and the reference timing signal S(4), the reference timing generating circuit 103 corrects the reference timing signal S(4) so that this coincides with the reception timing signal S(2).

However, in general, a reception wave in a radio communication is transmitted as a "multi-path" consisting of a direct wave that arrives directly and a plurality of reflection waves that arrive after reflecting from buildings or the like. An amount of delay in a reflection wave from a direct wave is not constant, and this amount of delay changes dynamically as it is controlled by the surrounding buildings and the topography. Further, at the mobile station, a reception timing of a reception wave changes every moment due to a change in the propagation route according to a move.

Thus, in the mobile communication environment, a direct wave is not always received, and sometimes the reception timing is detected from the reflection wave, and a reception reference timing is corrected by mistake in such a manner that it coincides with the reception timing of the reflection wave. Moreover, sometimes, at the next timing, a reception timing is detected from a direct wave, and a reception reference timing is corrected such that it coincides with the reception timing of the direct wave.

As explained above, according to the conventional clock correcting device described in the above-mentioned reference, there has been a problem that, when there is a large propagation path difference between a direct wave and a reflection wave, a reception reference timing is corrected frequently, and a switching of a received RAKE path occurs

frequently, with a result that the load amount of correcting a reception reference timing increases. Further, according to the conventional clock correcting device, there has also been a problem that the frequency of updating a path allocation to a finger increases due to an erroneous tracking of a reception reference timing.

The present invention has been made in the light of the above problems. It is an object of this invention to provide a method of and a device for correcting a timing that is capable of determining a reception reference timing efficiently and in optimum, by realizing a reduction in the load amount of correcting a reception reference timing and a reduction in the frequency of updating a path allocation.

DISCLOSURE OF THE INVENTION

The timing correcting device relating to one aspect of the present invention comprises: a path detecting unit (corresponding to a RAKE path detecting circuit 1 in an embodiment to be described later) which detects a plurality of path candidates to be tracked from a reception signal, and outputting a "path timing" and a "detection correlation value" corresponding to each path candidate as a result; a plurality of decision reference generating units (corresponding to tracking-path candidate deciding circuits 2a, 2b, 2c, ...) that are individually allocated

with a result of the detection, which generate a predetermined decision standard that is necessary for selecting an optimum path timing from among the timings of the path candidates, based on the allocated information; an optimum-path selecting unit (corresponding to a tracking-path selecting circuit 3) which selects an optimum path timing that should be tracked from among the timings of the path candidates, based on a result of the detection and the predetermined decision standard; a phase-difference calculating unit (corresponding to a comparator circuit 5) which compares a predetermined reception reference timing given from the outside with the optimum path timing, and calculating a phase difference between the two; and a timing correcting unit (corresponding to a timing correction control circuit 6, a clock generating circuit 7, and a reception reference counter 4) which corrects the reception reference timing by controlling a clock based on the phase difference.

According to the above-mentioned aspect of this invention, an optimum path around a reception reference timing is selected based on an output from each decision reference generating unit, and an internal clock is corrected based on a phase difference between the selected path and a predetermined reception reference timing. Thus, a center of a searcher and a finger window is always matched with

the reception reference timing. With this arrangement, it is possible to efficiently carry out a multi-path detection around the reception reference timing, and it becomes possible to decrease the load amount of correcting the reception reference timing. Further, it is also possible to substantially decrease the frequency of updating a path allocation, as compared with the conventional technique of updating a path at timing other than around the reception reference timing too.

In the timing correcting device of this invention, the optimum-path selecting unit has a "path selection status", a "forward alignment status", and a "tracking-path holding status" as statuses, wherein, during the "path selection status", the timing correcting device selects the optimum path timing from among the path candidates based on the detection correlation value or the predetermined decision standard, and thereafter shifts the status from the "path selection status" to the "tracking-path holding status", during the "tracking-path holding status", the timing correcting device compares a result of a detection of a latest path with a timing of a current optimum path thereby to decide whether a path updating processing is to be carried out or not, and carries out the updating processing when a path that satisfies a predetermined updating condition exists as a result of the comparison, and shifts the status from

the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and during the "forward alignment status", the timing correcting device holds a current optimum path timing when a path exists within a number of forward alignment stages even when paths do not exist within the range of an error of a predetermined number of samples prescribed in advance, and the timing correcting device shifts the status from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

Thus, because of the provision of the optimum-path selecting unit, it is possible to shift immediately to the "tracking-path holding status" by selecting an optimum path timing from timings of the output paths of each decision reference generating unit, without making a shift to the backward alignment status, even when the status has been shifted to the "path selection status", for example. Therefore, it is possible to substantially improve the operation speed relating to a timing correction.

In the timing correcting device of this invention, during the "path selection status", the timing correcting device makes each of the decision reference generating unit have a priority as the predetermined decision standard, and

selects a timing of a path allocated to the decision reference generating unit having a highest priority as an optimum path timing.

Thus, because of the provision of the optimum-path selecting unit which selects a timing of a path having a highest priority, it is possible to select a most stable path from among a plurality of path candidates.

In the timing correcting device of this invention, during the "path selection status", the timing correcting device utilizes the detection correlation value as one of the predetermined decision standards, and selects a timing of a path allocated to decision reference generating unit having a largest detection correlation value as an optimum path timing.

Thus, because of the provision of the optimum-path selecting unit which selects a timing of a path having a largest detection correlation value, it is possible to select a most stable path from among a plurality of path candidates.

In the timing correcting device of this invention, during the "path selection status", the timing correcting device makes each of the decision reference generating unit have stability information of a detection correlation value as the predetermined decision standard, and selects a timing of a path allocated to decision reference generating unit having correlation value stability information of a smallest

variation in correlation values, as an optimum path timing.

Thus, because of the provision of the optimum-path selecting unit which selects a timing of a path having correlation value stability information of a smallest variation in correlation values, it is possible to select a most stable path from among a plurality of path candidates.

In the timing correcting device of this invention, when a path exists within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", this path satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

Thus, when a path exists within a range of an error of a predetermined number of samples prescribed in advance, this path satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable path to the phase-difference calculating unit.

In the timing correcting device of this invention, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", a path nearest to a current optimum path timing satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path

as a next optimum path timing.

Thus, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance, a path nearest to a current optimum path timing satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable path to the phase-difference calculating unit.

In the timing correcting device of this invention, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing as a result of a comparison in the "tracking-path holding status", a path having a higher detection correlation value satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

Thus, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing, a path having a higher detection correlation value satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable path to the phase-difference calculating unit.

In the timing correcting device of this invention, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing as a result of a comparison in the "tracking-path holding status", a path having a tracking polarity direction that is the same as a past tracking direction satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

Thus, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing, a path having a tracking polarity direction that is the same as a past tracking direction satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable path to the phase-difference calculating unit.

In the timing correcting device of this invention, the decision reference generating unit has a "path selection status", a "backward alignment status", a "forward alignment status", and a "tracking-path holding status" as statuses, wherein, during the "path selection status", the timing correcting device outputs a timing of an allocated path based

on a result of the detection, and thereafter shifts the status from the "path selection status" to the "backward alignment status", during the "backward alignment status", the timing correcting device compares a result of a latest path detection with a timing of a current output path, and shifts the status from the "backward alignment status" to the "path selection status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and when a path exists within a range of an error of a predetermined number of samples prescribed in advance and further when paths exist continuously over and above a number of backward alignment stages, the timing correcting device shifts the status from the "backward alignment status" to the "tracking-path holding status", during the "tracking-path holding status", the timing correcting device compares a result of a detection of a latest path with a timing of a current output path thereby to decide whether a path updating processing is to be carried out or not, and carries out the updating processing when a path exists that satisfies a predetermined updating condition as a result of the comparison, and the timing correcting device shifts the status from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and during the "forward

alignment status", the timing correcting device holds a current optimum path timing when a path exists within a number of forward alignment stages even when paths do not exist within the range of an error of a predetermined number of samples prescribed in advance, and the timing correcting device shifts the status from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

Thus, because of the provision of the plurality of decision reference generating units capable of outputting a timing of an allocated path, it is possible to promptly select an optimum path even if the optimum-path selecting unit has overlooked a path. Therefore, it is possible to execute a secure clock correction.

In the timing correcting device of this invention, when a path exists within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", this path satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

Thus, when a path exists within a range of an error of a predetermined number of samples prescribed in advance, this path satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable

path to the optimum-path selecting unit.

In the timing correcting device of this invention, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", a path nearest to a current output path timing satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

Thus, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance, a path nearest to a current optimum path timing satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable path to the optimum-path selecting unit.

In the timing correcting device of this invention, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current output path timing as a result of a comparison in the "tracking-path holding status", a path having a higher detection correlation value satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

Thus, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing, a path having a higher detection correlation value satisfies the predetermined updating condition. Therefore, it is possible to provide a timing of a most stable path to the optimum-path selecting unit.

In the timing correcting device of this invention, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current output path timing as a result of a comparison in the "tracking-path holding status", a path having a tracking polarity direction that is the same as a past tracking direction satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

Thus, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing, a path having a tracking polarity direction that is the same as a past tracking direction satisfies the predetermined updating condition. Therefore, it is possible to provide

a timing of a most stable path to the optimum-path selecting unit.

The timing correcting device calculates the stability information held by each decision reference generating unit by using the detection correlation value, a moving average of variation widths of the detection correlation value, an average of total past variation widths, a moving sum of variation widths, a moving average of detection correlation values, and/or a combination of these values.

Thus, because of the provision of the plurality of decision reference generating units which calculates the stability information, the optimum-path selecting unit can select a most stable path from among a plurality of path candidates. With this arrangement, it is also possible to substantially decrease the frequency of updating a path due to an erroneous tracking of a multi-path. As a result, it is possible to prevent a wasteful clock correction that has occurred in the past.

The timing correcting method relating to another aspect of this invention comprises: a path detecting step of detecting a plurality of path candidates to be tracked from a reception signal, and outputting a "path timing" and a "detection correlation value" corresponding to each path candidate as a result; a decision reference generating step of individually allocating a result of the detection, and

generating a predetermined decision standard that is necessary for selecting an optimum path timing from among the timings of the path candidates, based on the allocated information; an optimum-path selecting step of selecting an optimum path timing that should be tracked from among the timings of the path candidates, based on a result of the detection and the predetermined decision standard; a phase-difference calculating step of comparing a predetermined reception reference timing given from the outside with the optimum path timing, and calculating a phase difference between the two; and a timing correcting step of correcting the reception reference timing by controlling a clock based on the phase difference.

Thus, an optimum path around a reception reference timing is selected based on an output at the decision reference generating step, and an internal clock is corrected based on a phase difference between the selected path and a predetermined reception reference timing. Thus, a center of a searcher and a finger window is always matched with the reception reference timing. With this arrangement, it is possible to efficiently carry out a multi-path detection around the reception reference timing, and it becomes possible to decrease the load amount of correcting the reception reference timing. Further, it is also possible to substantially decrease the frequency of updating a path

allocation, as compared with the conventional technique of updating a path at timing other than around the reception reference timing too.

In the timing correcting method of this invention, the optimum-path selecting step has a "path selection status", a "forward alignment status", and a "tracking-path holding status" as statuses, wherein, during the "path selection status", the optimum path timing is selected from among the path candidates based on the detection correlation value or the predetermined decision standard, and thereafter the status is shifted from the "path selection status" to the "tracking-path holding status", during the "tracking-path holding status", a result of a detection of a latest path is compared with a timing of a current optimum path thereby to decide whether a path updating processing is to be carried out or not, and the updating processing is carried out when a path exists that satisfies a predetermined updating condition as a result of the comparison, and the status is shifted from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and during the "forward alignment status", a current optimum path timing is held when a path exists within a number of forward alignment stages even when paths do not exist within the range of an error of a

predetermined number of samples prescribed in advance, and the status is shifted from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

Thus, based on the inclusion of the optimum-path selecting step, it is possible to shift immediately to the "tracking-path holding status" by selecting an optimum path timing from timings of the output paths of each decision reference generating unit, without making a shift to the backward alignment status, even when the status has been shifted to the "path selection status", for example. Therefore, it is possible to substantially improve the operation speed relating to a timing correction.

In the timing correcting method of this invention, the decision reference generating step has a "path selection status", a "backward alignment status", a "forward alignment status", and a "tracking-path holding status" as statuses, wherein, during the "path selection status", a timing of an allocated path is output based on a result of the detection, and thereafter the status is shifted from the "path selection status" to the "backward alignment status", during the "backward alignment status", a result of a latest path detection is compared with a timing of a current output path, and the status is shifted from the "backward alignment status" to the "path selection status" when paths do not

exist within a range of an error of a predetermined number of samples prescribed in advance, and when a path exists within a range of an error of a predetermined number of samples prescribed in advance and further when paths exist continuously over or above a number of backward alignment stages, the status is shifted from the "backward alignment status" to the "tracking-path holding status", during the "tracking-path holding status", a result of a detection of a latest path is compared with a timing of a current output path thereby to decide whether a path updating processing is to be carried out or not, and the updating processing is carried out when a path exists that satisfies a predetermined updating condition as a result of the comparison, and the status is shifted from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and during the "forward alignment status", a current optimum path timing is held when a path exists within a number of forward alignment stages even when paths do not exist within the range of an error of a predetermined number of samples prescribed in advance, and the status is shifted from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

Thus, because of the provision of the decision reference generating step of outputting a timing of an allocated path, it is possible to promptly select an optimum path even if a path has been overlooked at the optimum-path selecting step. Therefore, it is possible to execute a secure clock correction.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing a structure of a timing correcting device relating to the present invention; Fig. 2 is a diagram showing a shift of a status of a tracking-path selecting circuit; Fig. 3 is a diagram showing a shift of a status of each tracking-path candidate deciding circuit; and Fig. 4 is a diagram showing a structure of a conventional timing correcting device.

BEST MODE FOR CARRYING OUT THE INVENTION

The present invention will be explained in detail below with reference to the attached drawings.

To begin with, a structure of a timing correcting device relating to the present invention will be explained. Fig. 1 is a diagram showing a structure of the timing correcting device relating to the present invention. In Fig. 1, 1 denotes a RAKE path detecting circuit, 2a, 2b, 2c, ... denote tracking-path candidate deciding circuits, 3 denotes a

tracking-path selecting circuit, 4 denotes a reception reference counter, 5 denotes a comparator circuit, 6 denotes a timing correction control circuit, and 7 denotes a clock generating circuit.

The operation of the timing correcting device relating to the present invention will be explained below. A reception base-band signal received by a mobile unit is input into the RAKE path detecting circuit 1. The RAKE path detecting circuit 1 detects a plurality of valid path candidates based on this reception signal. Thereafter, the RAKE path detecting circuit 1 outputs a "timing of each path" and a "detection correlation value" as a result of the RAKE path detection, to the tracking-path candidate deciding circuits 2a, 2b, 2c, ..., and the tracking-path selecting circuit 3. The RAKE detection is carried out in an over-sampling period of n (an integer) times.

The above "timing of each path" and " detection correlation value" are allocated to each tracking-path candidate deciding circuit in a detection path unit. Each tracking-path candidate deciding circuit generates and outputs a predetermined decision standard that is necessary for the tracking-path selecting circuit 3 to select an optimum path. The tracking-path selecting circuit 3 selects an optimum path to be tracked from among the detected paths, based on the result of the RAKE path detection and

the predetermined decision standards. The "path timing" that is output from each tracking-path candidate deciding circuit as one of the predetermined decision standards will hereinafter be called a second main path timing.

Specifically, in the initial status, the tracking-path selecting circuit 3 selects an optimum path based on a result of the RAKE path detection. In the status other than the initial status, the tracking-path selecting circuit 3 selects an optimum path from among paths corresponding to the second main path timing, based on the predetermined decision standard

Thereafter, the tracking-path selecting circuit 3 outputs the selected "path timing" as the "path timing" to be tracked, to the comparator circuit 5. The "path timing" that is output from the tracking-path selecting circuit as the path timing to be tracked will hereinafter be called a first main path timing.

The comparator circuit 5 that has received the first main path timing compares a predetermined reception reference timing given from the outside and a reference counter value counted based on a clock signal from the clock generating circuit 7 with the first main path timing. Specifically, for example, an internal clock held by a mobile unit and an internal clock held by a base station do not operate completely in the same period, but have a constant

clock deviation between them. This clock deviation may not be constant due to an influence of phasing or the like. Therefore, in order to receive accurately the information transmitted from the base station, it is necessary that this clock deviation is always corrected. For this purpose, the comparator circuit 5 checks whether there has been a deviation between the first main path timing and the reception reference timing set at the time of opening the reception channel, by carrying out the above comparison.

However, as the first main path timing expresses a timing of a common control channel and the reception reference timing expresses a reception reference timing, the comparator circuit 5 carries out a comparison after standardizing the timing based on one channel.

Thereafter, a phase difference between these timings detected by the comparator circuit 5 is output to the timing correction control circuit 6. The timing correction control circuit 6 outputs a correction quantity corresponding to this phase difference to the clock generating circuit 7 at every constant period (period frame). For example, when there is a phase difference of a predetermined value (for example, 1/4 chip) or above between the reception reference timing and the first main path timing, the timing correction control circuit 6 generates a clock correction instruction to the clock generating circuit 7

at a rate of once per the above constant period frame. The clock generating circuit 7 corrects the counter value according to the posted correction quantity.

As explained above, according to the present embodiment, an optimum path around the reception reference timing is selected based on the output from each tracking-path candidate deciding circuit. The internal clock is corrected based on a phase difference between the selected path and the predetermined reception reference timing. Thus, a center of a searcher and a finger window is always matched with the reception reference timing. With this arrangement, it is possible to efficiently carry out a multi-path detection around the reception reference timing, and it becomes possible to decrease the load amount of correcting the reception reference timing. Further, it is also possible to substantially decrease the frequency of updating a path allocation, as compared with the conventional technique of updating a path at timing other than around the reception reference timing too.

The operation of the tracking-path selecting circuit 3 will now be explained in detail. Fig. 2 is a diagram showing a shift of a status of the tracking-path selecting circuit 3. The tracking-path selecting circuit 3 has a "path selection status", a "forward alignment status", and a "tracking-path holding status" as statuses, for example.

During the "path selection status" in the case of opening a channel, the tracking-path selecting circuit 3 selects a path having a largest detection correlation value as a path corresponding to the first main path timing from among the paths detected by the RKE path detecting circuit 1. On the other hand, during the "path selection status" in other cases, the tracking-path selecting circuit 3 selects a path corresponding to the first main path timing from among the paths allocated as a plurality of second main path timings. However, when there is no path that can be allocated as the second main path timing, the tracking-path selecting circuit 3 does not update the first main path timing. In the above operation, when a path corresponding to the first main path timing has been selected, the tracking-path selecting circuit 3 shifts the status from the "path selection status" to the "tracking-path holding status".

A method of selecting an optimum path corresponding to the first main path timing will be explained in detail below.

(1) As a first method, a priority is set to each tracking-path candidate deciding circuit in advance. Then, a path corresponding to a second main path timing that has been output from a tracking-path candidate deciding circuit having a highest priority is selected as a path that corresponds to the first main path timing. However, when

the updating of the first main path timing has occurred by a specific number or more times during a constant period of time, the priority of a tracking-path candidate deciding circuit that has a second priority at present is increased by one.

(2) As a second method, from among a plurality of paths that have been allocated as second main path timings in the tracking status, a path having a largest detection correlation value is selected as a path that corresponds to the first main path timing.

(3) As a third method, from among a plurality of paths that have been allocated as second main path timings in the tracking status, a path having a smallest detection correlation value based on correlation stability information of each tracking-path candidate deciding circuit is selected as a path that corresponds to the first main path timing.

Next, during the "tracking-path holding status", each time when the RAKE path detecting circuit 1 has updated the RAKE path, the tracking-path selecting circuit 3 compares a result of the RAKE path detection with a current first main path timing, and decides whether an update processing is to be carried out or not. This will be explained in more detail.

(1) For example, as a result of a comparison between a

RAKE path and a current first main path timing, when the RAKE path exists within a range of an error of a predetermined number of samples prescribed in advance, the tracking-path candidate deciding circuit 3 sets a timing of this RAKE path as a next first main path timing.

(2) Further, as a result of a comparison between a RAKE path and a current first main path timing, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance, the tracking-path candidate deciding circuit 3 sets a timing of a path nearest to the first main path timing as a next first main path timing.

(3) Further, as a result of a comparison between a RAKE path and a current first main path timing, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from the first main path timing, the tracking-path candidate deciding circuit 3 sets a timing of a path having a higher detection correlation value as a next first main path timing.

(4) Further, in the above case (3), it is also possible to set as a next first main path timing a timing of a path having a tracking polarity direction that is the same as a past tracking direction.

Further, as a result of a comparison between a RAKE path and a current first main path timing, when paths do

not exist within a range of an error of a predetermined number of samples prescribed in advance, or when paths exist within a range of an error of a predetermined number of samples but the detection correlation value does not reach a constant threshold value, the tracking-path selecting circuit 3 in the "tracking-path holding status" shifts the status to the "forward alignment status".

Finally, as a result of a comparison between a RAKE path and a current first main path timing, when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance but when paths exist within a number of the forward alignment states, the tracking-path selecting circuit 3 in the "forward alignment status" holds the current tracking path as a path that corresponds to the first main path timing. In other words, the tracking-path selecting circuit 3 does not update the path. On the other hand, when paths do not exist continuously over or above a number of the forward alignment stages, the tracking-path selecting circuit 3 shifts the status from the "forward alignment status" to the "path selection status".

As explained above, according to the present embodiment, because of the provision of the tracking-path selecting circuit 3, it is possible to shift immediately to the "tracking-path holding status" by selecting an optimum first main path timing from the second main path timings

without making a shift to the backward alignment status, even when the status has been shifted to the "path selection status", for example. Therefore, it is possible to substantially improve the operation speed relating to a timing correction.

The operation of the tracking-path candidate deciding circuits 2a, 2b, 2c, ... will now be explained in detail. Fig. 3 is a diagram showing a shift of a status of each tracking-path candidate deciding circuit. Each tracking-path candidate deciding circuit has, for example, a "path selection status", a "backward alignment status", a "forward alignment status", and a "tracking-path holding status" as statuses, and carries out a tracking operation to each different path.

During the "path selection status", m (where m is any desired integer) tracking-path candidate deciding circuits are allocated with m paths in the order of a large detection correlation value from among all paths that have been detected by the RAKE path detecting circuit 1. The m tracking-path candidate deciding circuits receive "path timings" and "detection correlation values" corresponding to respective paths. Then, each tracking-path candidate deciding circuit outputs a second main path timing corresponding to the allocated path, and shifts to the "backward alignment status".

During the "backward alignment status", each tracking-path candidate deciding circuit compares a result of the RAKE path detection with a current second main path timing. When paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, the tracking-path candidate deciding circuit shifts the status from the "backward alignment status" to the "path selection status". On the other hand, when paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when paths exist continuously over and above a number of backward alignment stages, the tracking-path candidate deciding circuit shifts the status from the "backward alignment status" to the "tracking-path holding status".

During the "backward alignment status", each time when the RAKE path has been updated by the RAKE path detecting circuit 1, each tracking-path candidate deciding circuit compares a result of the RAKE path detection with a current second main path timing, and decides whether the update processing is to be carried out or not. This will be explained in more detail.

(1) For example, as a result of a comparison between a RAKE path and a current second main path timing, when the RAKE path exists within a range of an error of a predetermined number of samples prescribed in advance, the tracking-path

candidate deciding circuit 3 sets a timing of this RAKE path as a next first main path timing.

(2) Further, as a result of a comparison between a RAKE path and a current second main path timing, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance, the tracking-path candidate deciding circuit 3 sets a timing of a path nearest to the second main path timing as a next second main path timing.

(3) Further, as a result of a comparison between a RAKE path and a current second main path timing, when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from the second main path timing, the tracking-path candidate deciding circuit 3 sets a timing of a path having a higher detection correlation value as a next second main path timing.

(4) Further, in the above case (3), it is also possible to set as a next second main path timing a timing of a path having a tracking polarity direction that is the same as a past tracking direction.

Further, during the "tracking-path holding status", each tracking-path candidate deciding circuit holds stability information of a detection correlation value.

The stability of a detection correlation value is calculated by using a variation width of the detection correlation value. For example, when S(x) represents a variation width of a detection correlation value and L (x) represents a detection correlation value during a time x, the variation width S(x) can be expressed as shown in the expression (1).

$$S(x) = |L\ (x) - L\ (x - 1)| \qquad \ldots\ (1)$$

When x = 0, then S(x - 1) = 0. The stability of a detection correlation value is calculated form a variation width of the detection correlation value. It is also possible to calculate the stability based on a moving average of variation widths of the detection correlation value, an average of total past variation widths, a moving sum of variation widths, a moving average of detection correlation values, and/or a combination of these values.

As a result of a comparison with a current second main path timing, when a path does not exist within a range of an error of a predetermined number of samples prescribed in advance, the tracking-path candidate deciding circuit in the "tracking-path holding status" shifts the status to the "forward alignment status".

Finally, during the "forward alignment status", as a result of a comparison with a current second main path timing, when a path exists within a number of forward alignment stages even when paths do not exist within a range

of an error of a predetermined number of samples prescribed in advance, each tracking-path candidate deciding circuit holds a current tracking path as a second main path timing. In other words, the tracking-path candidate deciding circuit does not update the path. On the other hand, when paths do not exist continuously over or above a number of the forward alignment stages, the tracking-path candidate deciding circuit shifts the status from the "forward alignment status" to the "path selection status".

As explained above, according to the present embodiment, because of the provision of a plurality of tracking-path candidate deciding circuits capable of outputting the second main path timing, it is possible to promptly select an optimum path even if the tracking-path selecting circuit 3 has overlooked a path. Therefore, it is possible to execute a more secure clock correction.

Further, according to the present embodiment, because of the provision of a plurality of tracking-path candidate deciding circuits capable of holding the stability information of the detection correlation value, the tracking-path candidate deciding circuit 3 select a most stable path from among a plurality of path candidates. With this arrangement, it is possible to substantially decrease the frequency of updating a path due to an erroneous tracking of a multi-path. As a result, it is possible to prevent

a wasteful clock correction that has occurred in the past.

INDUSTRIAL APPLICABILITY

As explained above, the timing correcting device and the timing correcting method relating to the present invention are useful for a mobile communication system that employs the CDMA system. Particularly, the timing correcting device and the timing correcting method are suitable for a mobile station accommodated in the mobile communication system, that is, a demodulator of a portable telephone that requires a synchronous control within the mobile communication system.

CLAIMS

1. A timing correcting device comprising:

a path detecting unit which detects a plurality of path candidates to be tracked from a reception signal, and outputting a "path timing" and a "detection correlation value" corresponding to each path candidate as a result;

a plurality of decision reference generating units that are individually allocated with a result of the detection, which generate a predetermined decision standard that is necessary for selecting an optimum path timing from among the timings of the path candidates, based on the allocated information;

an optimum-path selecting unit which selects an optimum path timing that should be tracked from among the timings of the path candidates, based on a result of the detection and the predetermined decision standard;

a phase-difference calculating unit which compares a predetermined reception reference timing given from the outside with the optimum path timing, and calculates a phase difference between the two timings; and

a timing correcting unit which corrects the reception reference timing by controlling a clock based on the phase difference.

2. The timing correcting device according to claim 1, wherein

the optimum-path selecting unit has a "path selection status", a "forward alignment status", and a "tracking-path holding status" as statuses,

during the "path selection status", the timing correcting device selects the optimum path timing from among the path candidates based on the detection correlation value or the predetermined decision standard, and thereafter shifts the status from the "path selection status" to the "tracking-path holding status",

during the "tracking-path holding status", the timing correcting device compares a result of a detection of a latest path with a timing of a current optimum path thereby to decide whether a path updating processing is to be carried out or not, and carries out the updating processing when a path that satisfies a predetermined updating condition exists as a result of the comparison, and shifts the status from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and

during the "forward alignment status", the timing correcting device holds a current optimum path timing when a path exists within a number of forward alignment stages

even when paths do not exist within the range of an error of a predetermined number of samples prescribed in advance, and the timing correcting device shifts the status from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

3. The timing correcting device according to claim 2, wherein

during the "path selection status", the timing correcting device makes each decision reference generating unit has a priority as the predetermined decision standard, and selects a timing of a path allocated to the decision reference generating unit having a highest priority as an optimum path timing.

4. The timing correcting device according to claim 2, wherein

during the "path selection status", the timing correcting device utilizes the detection correlation value as one of the predetermined decision standards, and selects a timing of a path allocated to the decision reference generating unit having a largest detection correlation value as an optimum path timing.

5. The timing correcting device according to claim 2, wherein

during the "path selection status", the timing correcting device makes each of the decision reference generating unit has stability information of a detection correlation value as the predetermined decision standard, and selects a timing of a path allocated to the decision reference generating unit having correlation value stability information of a smallest variation in correlation values, as an optimum path timing.

6. The timing correcting device according to claim 2, wherein

when a path exists within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", this path satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

7. The timing correcting device according to claim 2, wherein

when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path

holding status", a path nearest to a current optimum path timing satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

8. The timing correcting device according to claim 2, wherein

when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing as a result of a comparison in the "tracking-path holding status", a path having a higher detection correlation value satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

9. The timing correcting device according to claim 2, wherein

when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current optimum path timing as a result of a comparison in the "tracking-path holding status", a path having a tracking polarity direction that is the same

as a past tracking direction satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next optimum path timing.

10. The timing correcting device according to claim 2, wherein

each decision reference generating unit has a "path selection status", a "backward alignment status", a "forward alignment status", and a "tracking-path holding status" as statuses,

during the "path selection status", the timing correcting device outputs a timing of an allocated path based on a result of the detection, and thereafter shifts the status from the "path selection status" to the "backward alignment status",

during the "backward alignment status", the timing correcting device compares a result of a latest path detection with a timing of a current output path, and shifts the status from the "backward alignment status" to the "path selection status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and when a path exists within a range of an error of a predetermined number of samples prescribed in advance and further when paths exist continuously over and above a number of backward alignment stages, the timing correcting

device shifts the status from the "backward alignment status" to the "tracking-path holding status",

during the "tracking-path holding status", the timing correcting device compares a result of a detection of a latest path with a timing of a current output path thereby to decide whether a path updating processing is to be carried out or not, and carries out the updating processing when a path exists that satisfies a predetermined updating condition as a result of the comparison, and the timing correcting device shifts the status from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and

during the "forward alignment status", the timing correcting device holds a current optimum path timing when a path exists within a number of forward alignment stages even when paths do not exist within the range of an error of a predetermined number of samples prescribed in advance, and the timing correcting device shifts the status from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

11. The timing correcting device according to claim 10, wherein

when a path exists within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", this path satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

12. The timing correcting device according to claim 10, wherein

when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance as a result of a comparison in the "tracking-path holding status", a path nearest to a current output path timing satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

13. The timing correcting device according to claim 10, wherein

when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current output path timing as a

result of a comparison in the "tracking-path holding status", a path having a higher detection correlation value satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

14. The timing correcting device according to claim 10, wherein

when a plurality of paths exist within a range of an error of a predetermined number of samples prescribed in advance and further when two paths exist at both poles and at equal distance from a current output path timing as a result of a comparison in the "tracking-path holding status", a path having a tracking polarity direction that is the same as a past tracking direction satisfies the predetermined updating condition, and the timing correcting device updates the timing of this path as a next output path timing.

15. The timing correcting device according to claim 5, wherein

the timing correcting device calculates the stability information held by each decision reference generating unit by using the detection correlation value, a moving average of variation widths of the detection correlation value, an average of total past variation widths, a moving sum of

variation widths, a moving average of detection correlation values, and/or a combination of these values.

16. A timing correcting method comprising:

a path detecting step of detecting a plurality of path candidates to be tracked from a reception signal, and outputting a "path timing" and a "detection correlation value" corresponding to each path candidate as a result;

a decision reference generating step of individually allocating a result of the detection, and generating a predetermined decision standard that is necessary for selecting an optimum path timing from among the timings of the path candidates, based on the allocated information;

an optimum-path selecting step of selecting an optimum path timing that should be tracked from among the timings of the path candidates, based on a result of the detection and the predetermined decision standard;

a phase-difference calculating step of comparing a predetermined reception reference timing given from the outside with the optimum path timing, and calculating a phase difference between the two; and

a timing correcting step of correcting the reception reference timing by controlling a clock based on the phase difference.

17. The timing correcting method according to claim 16, wherein

the optimum-path selecting step has a "path selection status", a "forward alignment status", and a "tracking-path holding status" as statuses,

during the "path selection status", the optimum path timing is selected from among the path candidates based on the detection correlation value or the predetermined decision standard, and thereafter the status is shifted from the "path selection status" to the "tracking-path holding status",

during the "tracking-path holding status", a result of a detection of a latest path is compared with a timing of a current optimum path thereby to decide whether a path updating processing is to be carried out or not, and the updating processing is carried out when a path exists that satisfies a predetermined updating condition as a result of the comparison, and the status is shifted from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and

during the "forward alignment status", a current optimum path timing is held when a path exists within a number of forward alignment stages even when paths do not exist

within the range of an error of a predetermined number of samples prescribed in advance, and the status is shifted from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

18. The timing correcting method according to claim 17, wherein

the decision reference generating step has a "path selection status", a "backward alignment status", a "forward alignment status", and a "tracking-path holding status" as statuses,

during the "path selection status", a timing of an allocated path is output based on a result of the detection, and thereafter the status is shifted from the "path selection status" to the "backward alignment status",

during the "backward alignment status", a result of a latest path detection is compared with a timing of a current output path, and the status is shifted from the "backward alignment status" to the "path selection status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and when a path exists within a range of an error of a predetermined number of samples prescribed in advance and further when paths exist continuously over or above a number of backward alignment

stages, the status is shifted from the "backward alignment status" to the "tracking-path holding status",

during the "tracking-path holding status", a result of a detection of a latest path is compared with a timing of a current output path thereby to decide whether a path updating processing is to be carried out or not, and the updating processing is carried out when a path exists that satisfies a predetermined updating condition as a result of the comparison, and the status is shifted from the "tracking-path holding status" to the "forward alignment status" when paths do not exist within a range of an error of a predetermined number of samples prescribed in advance, and

during the "forward alignment status", a current optimum path timing is held when a path exists within a number of forward alignment stages even when paths do not exist within the range of an error of a predetermined number of samples prescribed in advance, and the status is shifted from the "forward alignment status" to the "path selection status" when no continuous paths exist over or above a number of forward alignment stages.

ABSTRACT

In the timing correcting device, a RAKE path detecting circuit 1 detects a plurality of path candidates to be tracked, from a reception signal, and outputs a "timing of a path" and a "detection correlation value" corresponding to each path candidate, as a result of the detection. Next, each tracking-path candidate deciding circuit (2a, 2b, 2c, ...) generates a predetermined decision standard that is necessary for selecting an optimum path timing from timings of the path candidates, based on an individually allocated result of the detection. Further, the tracking-path selecting circuit 3 selects a timing of an optimum path to be tracked, based on the result of the detection and the predetermined decision standards. Then, a comparator circuit 5 compares a predetermined reception reference timing given from the outside with the optimum path timing, and calculates a phase difference between the two. Last, the timing correction control circuit 6 controls a clock based on the phase difference, thereby to correct the reception reference timing.

FIG.1

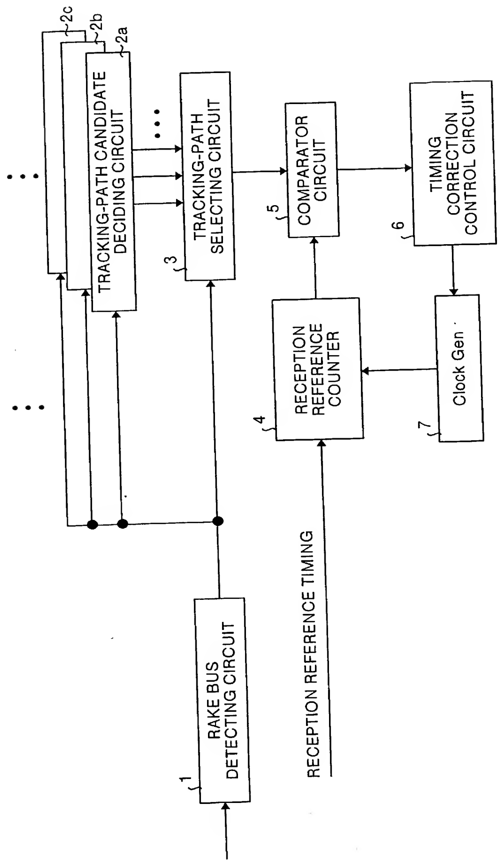

TRACKING-PATH CANDIDATE DECIDING CIRCUIT
2a
2b
2c
TRACKING-PATH SELECTING CIRCUIT
3
COMPARATOR CIRCUIT
5
TIMING CORRECTION CONTROL CIRCUIT
6
RECEPTION REFERENCE COUNTER
4
Clock Gen
7
RAKE BUS DETECTING CIRCUIT
1
RECEPTION REFERENCE TIMING

FIG.2

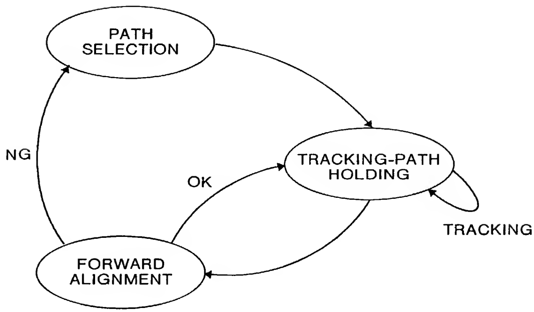

PATH SELECTION
TRACKING-PATH HOLDING
TRACKING
FORWARD ALIGNMENT
OK
NG

FIG.3

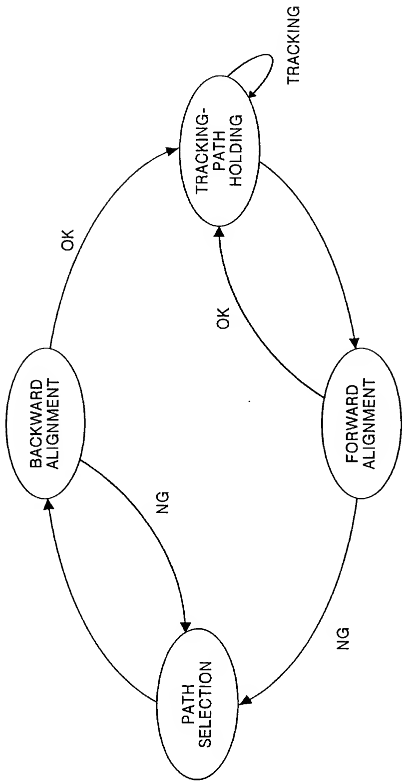
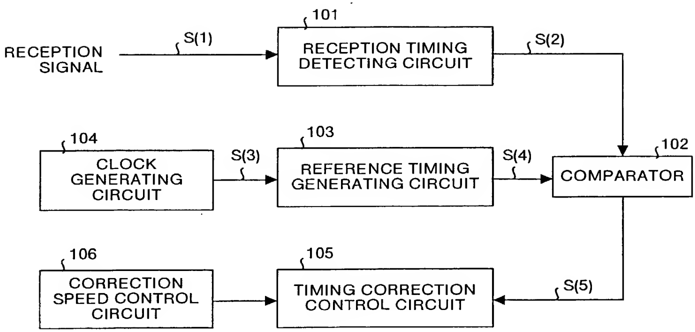

TRACKING
TRACKING-PATH HOLDING
OK
OK
BACKWARD ALIGNMENT
FORWARD ALIGNMENT
NG
NG
PATH SELECTION

FIG.4


RECEPTION SIGNAL
S(1)
101
RECEPTION TIMING DETECTING CIRCUIT
S(2)
104
CLOCK GENERATING CIRCUIT
S(3)
103
REFERENCE TIMING GENERATING CIRCUIT
S(4)
102
COMPARATOR
106
CORRECTION SPEED CONTROL CIRCUIT
105
TIMING CORRECTION CONTROL CIRCUIT
S(5)

Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

METHOD OF AND DEVICE FOR
CORRECTING A TIMING

上記発明の明細書は、

☐ 本書に添付されています。

☐ ____月____日に提出され、米国出願番号または特許協定条約国際出願番号を__________とし、（該当する場合）__________に訂正されました。

the specification of which

☒ is attached hereto.

☐ was filed on __________ as United States Application Number or PCT International Application Number __________ and was amended on __________ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration
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私は、米国法典第35編119条（a）-（d）項又は365条（b）項に基づき下記の、米国以外の国の少なくとも一ヵ国を指定している特許協力条約365（a）項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

Priority Claimed
優先権主張

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	☐ Yes はい	☐ No いいえ
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	☐ Yes はい	☐ No いいえ

私は、第35編米国法典119条（e）項に基づいて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

私は、下記の米国法典第35編120条に基づいて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条（c）に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1条56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)
(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

私は、私自信の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私の入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行なえば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration
（日本語宣言書）

委任状：私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
（弁護士、または代理人の指名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: *(list name and registration number)*

022850

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(Supply similar information and signature for third and subsequent joint inventors.)